Characterization of a Multi-Kilometer Long Tether Deployment, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

The E-Sail technology promises to provide a propellant-less propulsion that can obtain accelerations greater than 2 m/sec. This can lower trip times to any location in deep space with trips to 100 AU taking less than 10 years. This is less than half the time any current chemical, electric, or solar sail propulsion can do. The propulsion system can be scaled from CubeSats to full size exploration (Discovery Class) mission spacecraft. E-Sail propulsion repel the protons from the solar winds to push the vehicle. Much of the E-Sail technologies have been matured from recent NASA funded tests and studies. Parallel efforts in Europe are also maturing the concept. The highest risk element of the E-Sail are the tethers used to create the electrostatic field that repels the protons that propel the spacecraft. Deployment and control of these tethers presents a serious challenge.

This effort will develop high fidelity simulations and demonstrate deployment of up to 16 km long tethers. This risk reduction effort will allow a technology demonstration of the E-Sail in the 2021 time frame. Technology demonstrations are required to move the propulsion system forward. Ground based testing will reduce much of the risk of the remaining technologies but the tether deployments which have been a challenge require innovated testing approaches to reduce the risk and to develop techniques and control strategies to reduce the deployment risks

Anticipated Benefits

The E-Sail technology is scalable from small CubeSats to Discovery class missions allowing the exploration of our solar system by large numbers of CubeSats. The E-Sail with a network of tethers could provide mining missions to the asteroid belts. Since the propulsion system is propellant-less the spacecraft can be re-directed at any time. Missions to one of Saturn moons could be redirected to another moon once the initial mission was complete.

The resulting tether deployment system enables E-sail propelled systems to explore the asteroid belts in much shorter time frames than any other technology. The ability to survey and return to a particular asteroid allows commercial miners to narrow the potential targets for mining. The ability to redirect the spacecraft allows surveys to new potential mining sites on other asteroids. Development of higher fidelity tether models and knowledge will also benefit other low earth tether missions.

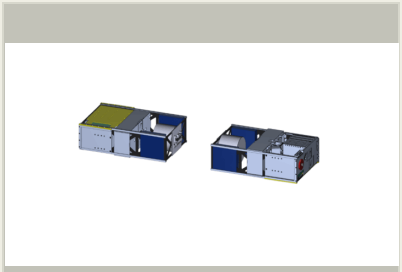

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Table of Contents

Small Business Innovation Research/Small Business Tech Transfer

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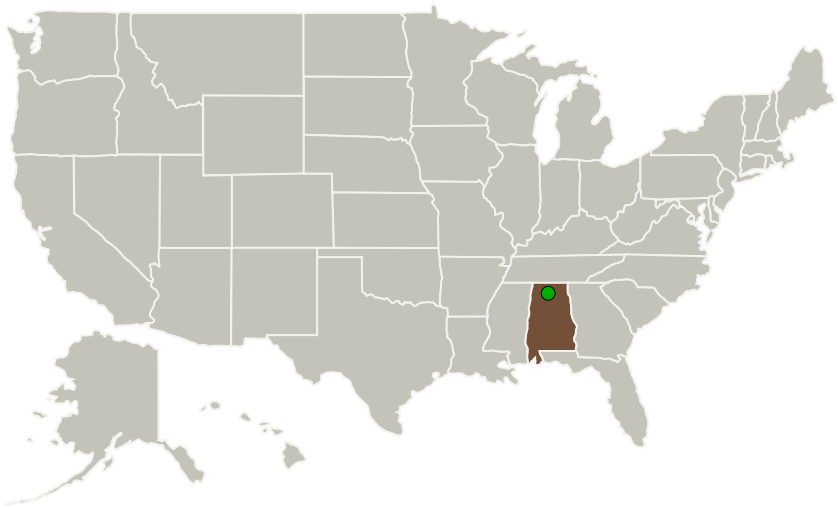
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Bangham Engineering Incorporated	Lead Organization	Industry Women-Owned Small Business (WOSB)	Huntsville, Alabama
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations
Alabama

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141301)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Bangham Engineering Incorporated

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

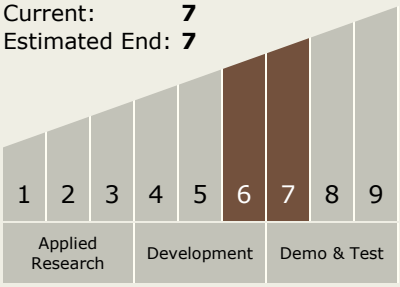
Carlos Torrez

Principal Investigator:

Mike Bangham

Technology Maturity (TRL)

Start: **6**
Current: **7**
Estimated End: **7**



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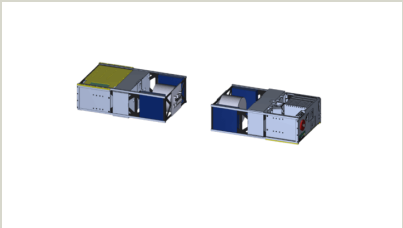
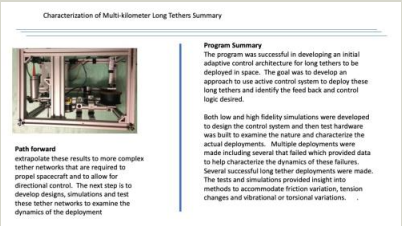
Images



Briefing Chart Image
Characterization of a Multi-Kilometer Long Tether Deployment, Phase I
(https://techport.nasa.gov/image/125953)



Final Summary Chart Image
Characterization of a Multi-Kilometer Long Tether Deployment, Phase I
(https://techport.nasa.gov/image/131702)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.4 Other Advanced Propulsion Approaches

Target Destinations

Earth, Others Inside the Solar System